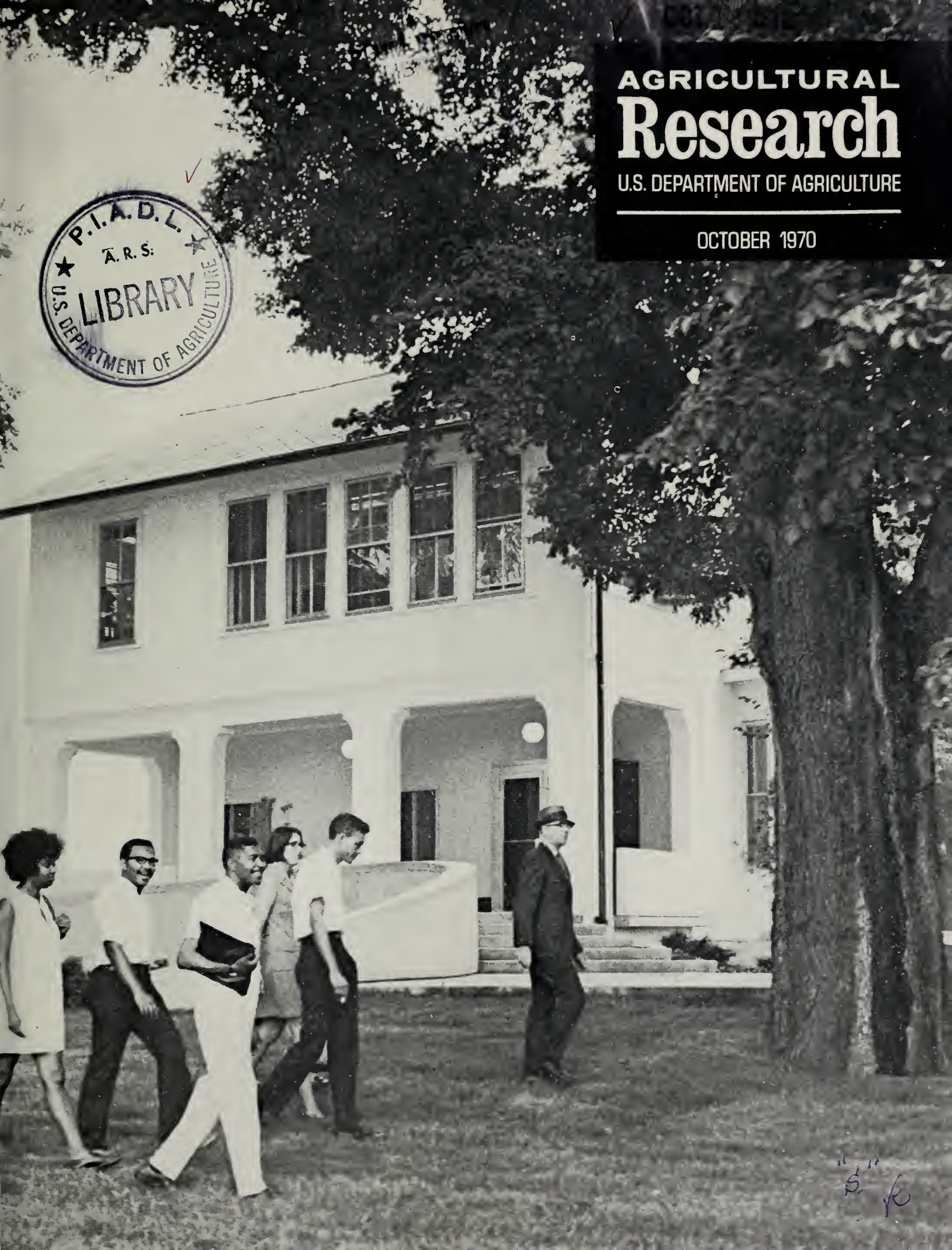

AGRICULTURAL Research

U.S. DEPARTMENT OF AGRICULTURE

OCTOBER 1970

AGRICULTURAL
Research

October 1970/Vol. 19, No. 4

A Story to Tell

A steady stream of visitors—now about 15,000 annually—come to view the march of agricultural progress at Beltsville, Md.

As the foremost facility of its kind in the world, the Agricultural Research Center attracts guests of diverse background and locale. For example, buses unload urban and suburban school children, often wide-eyed in a first encounter with a calf or chick. Other callers may be blue-jacketed FFA youths pursuing the latest discoveries of agricultural research. Then there are scientists, singly or in groups, sharing knowledge and keeping abreast of current projects. Still other visitors are from the general public, noting what their tax dollars are achieving, or merely enjoying a few informative hours in a scientific community.

This medley of visitors comes from every corner of the nation and globe. More than half live beyond metropolitan Washington, D.C. A tenth of all visitors are from abroad; in a typical year they represent about three-quarters of the world's nations.

A small visitor information staff serves the Center's cosmopolitan guests. The staff tailors each person's or group's tour to specific needs—whether an office visit between colleagues, an in-depth survey of research on a single topic such as entomology, or a general overview of work at the Center. These ARS tours are another way to "diffuse among the people" useful information on "subjects connected with agriculture," as mandated by the bill that Abraham Lincoln signed to create the Department of Agriculture.

The story of agricultural research needs to be told at every opportunity, not only at Beltsville, but at every agriculturally-related enterprise and facility, public and private. Today, 95 percent of our people live in towns and cities and many of them equate agriculture with plowing fields and harvesting crops. Yet agriculture is the wellspring of food for all Americans. Agricultural research has made food plentiful, raised living standards, and bolstered the economy. But continued progress requires public support, which in turn requires public understanding. Agricultural research has a good story to tell, but it is up to all of us to take the time to tell it.

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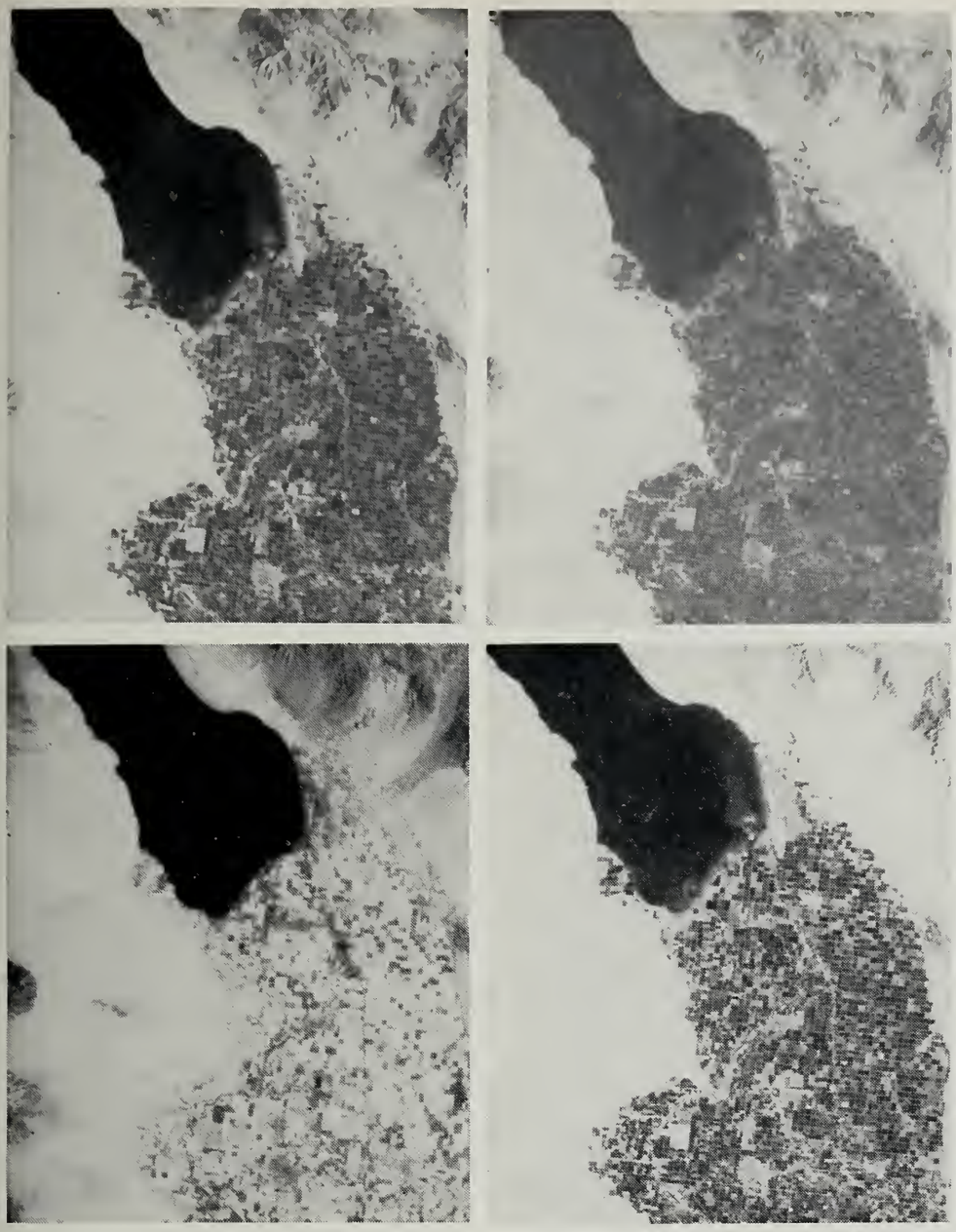
COVER: A group of biology students start a tour of the Agricultural Research Center in Beltsville, Md. (PN–1898).

AGRICULTURAL RESEARCH is published monthly by the Agricultural Research Service (ARS), United States Department of Agriculture, Washington, D.C. 20250. Printing has been approved by the Bureau of the Budget, June 1967. Yearly subscription rate is $1.50 in the United States and countries of the Postal Union, $2.00 in other countries. Single copies are 15 cents each. Subscription orders should be sent to Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Use of commercial names and brands is for identification only and does not imply endorsement or approval by USDA or ARS. Information in this periodical is public property and may be reprinted without permission. Mention of the source will be appreciated but is not required.

Clifford M. Hardin, Secretary
U.S. Department of Agriculture

G. W. Irving, Jr., Administrator
Agricultural Research Service



The multimulsion film at upper left has three layers which are sensitive to the green, red, and infrared wavelengths. It was compared with the product (multibase imagery) of the other three—black and white films sensitive respectively to green (upper right), infrared (lower left), and red (lower right) wavelengths (PN–1902, PN–1903, PN–1904, PN–1905).

Land use data from APOLLO 9

A 95-ACRE FIELD is an infinitesimal speck on a space photograph of 5,000 square miles. Enlarged 100 times, it still occupies much less than a tenth of a square inch.

But ARS scientists interpreted data from such space photographs (scale approximately 1: 3,000,000) to determine the crop or soil condition in 53 fields averaging 95 acres. Using highly sophisticated photographic recognition and computer analysis techniques, they accurately identified land use in about 70 percent of the fields.

The research was conducted by soil scientists Craig L. Wiegand and Ross W. Leamer; computer programmer and data analyst Daniel A. Weber; and research technician Alvin H. Gerbermann, all at Weslaco, Tex. The Texas Agricultural Experiment Station cooperated in the studies, supported by the National Aeronautics and Space Administration.

The Apollo 9 astronauts were 129 nautical miles above

earth when they photographed California's Imperial Valley and vicinity on March 12, 1969. Their photos (AGR. RES., July 1969, p. 8) were supplemented by ground truth data obtained during the mission by Norma Spansail and Don Lowe, University of Michigan. The Michigan scientists recorded crop species or soil conditions in 303 Imperial Valley fields in a 10½ by 1¾-mile area included in the space photographs.

The ARS scientists scanned the corresponding area on the photos with an isodensitracer, an instrument which plots measured optical density values of the films or film layers in two-dimensional tracings. After enlarging the isodensitracings 100-fold, they retraced them without a filter and with blue, green, or red filters in the light beam.

For 53 of the fields, Dr. Wiegand and his colleagues then compared by computer analysis optical density difference values among filters and films with average density difference values for the five land uses represented. The computer classified each field in the use it most closely resembled. Thirteen fields were barley; 10, sugarbeets; 10, alfalfa; 11, bare soil; and nine, salt flats.

The experiments also compared the usefulness of two sets of space data for identifying land use—imagery on multiemulsion infrared film and multibase imagery obtained with three black-and-white films.

Apollo 9 simultaneously photographed the Imperial Valley with four cameras, each with a different film-filter combination. One used a multiemulsion film whose three layers had peak sensitivities in the green, red, and infrared bands of the spectrum. The other three cameras were equipped with black-and-white films whose peak sensitivities were in the green, red, or infrared bands.

Sixty-eight percent of the fields were correctly identified from multi-

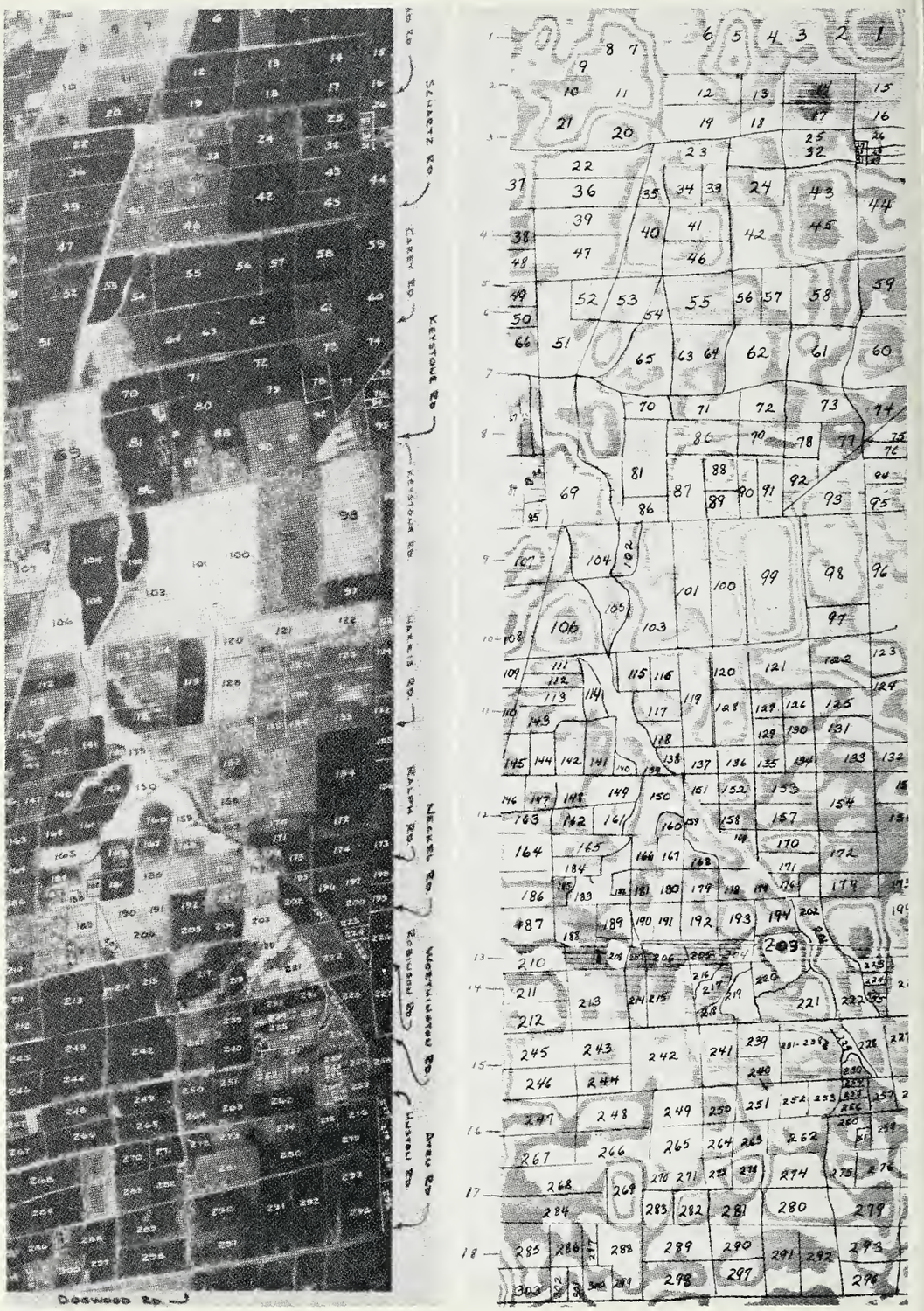


Photo of Imperial Valley from 10,000 feet is compared with an isodensitracing prepared from the space photograph of the same area. Numbers are field designations (PN–1896).

emulsion imagery, which was generally superior for determining crop categories. Accuracy was 72 percent with multibase imagery, which was superior for identifying bare soil and salt flats.

The scientists point out that the fields varied in plant height, proportion of ground covered, and row direction; some were salt-affected as well. All of these variations can affect accuracy of identification from remotely sensed imagery.

Overall, multibase and multiemulsion imagery proved almost equally useful for identifying crop and soil condition through optical density differences. ■

More Genetic Variants in Milk Casein

In the 30 years since the discovery that milk casein is not a homogeneous protein, scientists have been constantly challenged by the diversity and often the complexity of the individual caseins they have found. In the past 10 years, as methods of analysis have sharpened and the proteins of individual milks have been studied, certain patterns have emerged. The patterns are now known to be true examples of genetic polymorphism, that strange and wonderful variation in nature that distinguishes one individual from another.

Polymorphism might be the key to genetic control of milk caseins. Since these are the principal proteins of milk, the possibilities of breeding cows for the many protein-dependent properties of milk are obvious.

There are basically three kinds of milk casein—alpha, beta, and gamma—and ARS chemists were first to develop methods for separating them. Further variations have been cropping up. For example, alpha-casein has several components, the two most important being called alpha$_{s1}$ and kappa. Later, genetic variants were discovered for beta-casein (A, B, and C), alpha$_{s1}$-casein (A, B, C, and D), and kappa-casein (A and B).

That such variations represented genetic polymorphism was suggested by British researchers when they found the three variants of beta-casein. Using electrophoresis in analyzing individual milk samples, they showed that a given beta-casein will always be either A, B, or C, or a combination of two of them, reflecting the characteristics inherited from each parent of the cow producing the milk. They suggested the probable occurrence of genetic polymorphism in gamma-casein as well.

Recently ARS chemist Merton L. Groves, of the Eastern utilization research laboratory in Philadelphia, Pa., established this by finding two genetic variants of gamma-casein, A and B, in samples provided him by ARS dairy geneticist Charles A. Kiddy, of Beltsville, Md.

The polymorphism in gamma-casein shows a remarkable correspondence with that in beta-casein. Mr. Groves and his fellow chemist William G. Gordon have always found the corresponding types of these proteins together. If the beta-casein is A, the gamma will be too. If one is AB, so will be the other. If the beta is C, no gamma will be present (no gamma-casein C has been discovered).

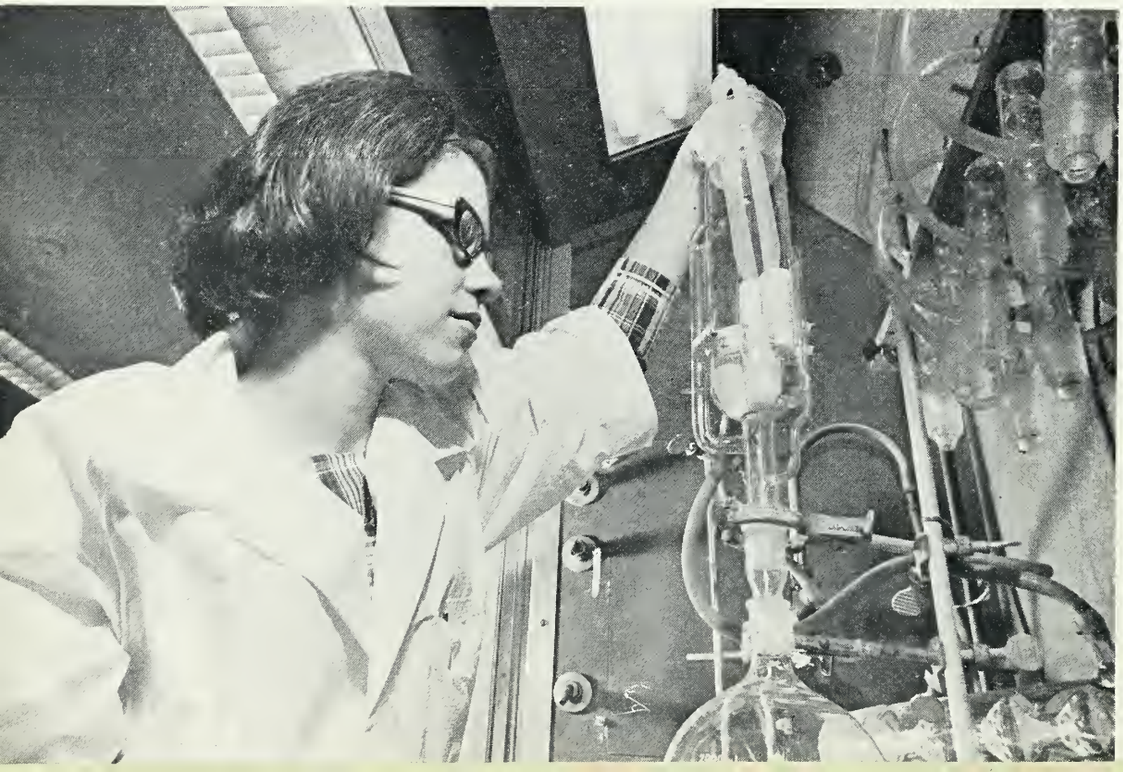
Mr. Groves also found that gamma-casein has three A variants, A^1, A^2, and A^3. This is a characteristic of beta-casein too, as another Eastern laboratory chemist, Robert F. Peterson, and his colleague, Frederick C. Kopfler, discovered earlier.

Dr. Gordon has made complete amino acid analyses of individual polymorphs of beta- and gamma-casein, and has shown remarkable similarities between them. This clinches the close genetic relationship between the two proteins, the significance of which is now being explored. ■

Mr. Groves analyzes milk caseins by gel electrophoresis. Protein solution is placed in the gel, and its components migrate in the electrical field according to the charge they carry (PN–1897).

Exploring nickel

Above: *Dr. Nielsen examines the legs of chicks in an isolator for the enlarged hocks, thickened legs, and other symptoms of nickel deficiency (770A598–16).* ***Below:*** *ARS technician Darla Higgs extracts fat to determine the fat level in test chick's liver. Fat levels are reduced when nickel is deficient in the diets (770A597–13).*



SYMPTOMS of nickel deficiency have been produced in chicks, indicating that this trace mineral may be essential for good health.

Mineral research as it concerns food was dormant for 20 years until evidence began accumulating that trace mineral deficiencies can—and do—exist in man. That these elements may be crucial in the human diet is becoming more apparent every day, bringing a new direction and sense of urgency to research in this field.

Latest breakthrough is the discovery that nickel may soon join chromium, copper, iodine, iron, zinc and other trace minerals on the list of nutrients essential to man.

When ARS research chemist Forrest H. Nielsen, Beltsville, Md., fed day-old chicks a diet low in nickel and compared them with control chicks receiving the same diet plus a nickel supplement, he found that they had developed these symptoms:

- Bright orange-yellow rather than pale brown-yellow leg color;
- Slightly enlarged hocks and slightly thickened legs near the hock area;
- Dermatitis on the shank skin.

There was also a change in liver texture, reduced liver fat content, and the chicks on the low nickel diet responded differently to the nickel-63 isotope used to trace the mineral's path through the body.

The first two of four experiments showed that after 3 weeks on a dried skim milk-cornmeal diet containing 79 parts per billion of nickel, chicks maintained in an all-plastic controlled environment system had bright orange-yellow legs, a slight thickening of the long bone and a slightly enlarged hock. Although this condition apparently was not painful, it caused a slightly abnormal clumsy gait.

deficiency

The nickel-deficient chicks retained about twice the amount of radioactive nickel in bone, liver, aorta, spleen, kidney, and cartilage as the nickel-supplemented chicks 6 hours after oral administration of nickel-63 isotope. No apparent differences in nickel-63 retention were found in muscle, blood, feather, duodenum, and skin.

Later experiments using an improved controlled environment system and a diet with less nickel indicated that other symptoms may accompany nickel-deficiency in chicks. Chicks fed a diet containing less than 40 ppb of nickel for a 4-week period not only duplicated the symptoms encountered in the earlier experiments, but also appeared less thrifty in general and had a slight dermatitis on the legs. There was some change in liver texture and other less definite changes involving a somewhat retarded growth rate and delayed comb development.

None of these changes affected chicks fed the same diet supplemented with 3 to 5 ppm of nickel as nickel chloride, thus indicating that this trace element may be essential in the diet.

Each experiment involved groups of 12- to 24-day-old White Rock or New Hampshire Red chicks. Dr. Nielsen took special precautions to minimize all sources of nickel. The diet made of natural foods was chosen because it contained essential vitamins and minerals in large enough amounts to obviate any major addition of nickel-contaminated chemicals.

Chicks were used because their high growth rate often appears to result in a greater requirement for specific minerals. Moreover, they often show more gross deficiency symptoms, especially in the legs, in mineral studies than do other laboratory animals. ■

MICROWAVES CONTROL NEMATODES

KILLING NEMATODE EGGS and larvae in seconds with high-power microwave energy may one day offer a suitable alternative to steam and chemical treatments for pasteurizing potting soils.

ARS nematologists John H. O'Bannon and Joseph M. Good at Beltsville, Md., used a small, home-type microwave oven to conduct two series of treatments on greenhouse composted soil that was infested with root-knot nematode eggs and larvae.

In one series of experiments, 90 cubic centimeters of screened soil with 11 percent moisture was divided into 30 petri dishes 1.7 centimeters deep covered with lids. In the second series, 400 cc of soil at 13 percent moisture was placed in uncovered 5 cm petri dishes. Each soil sample was treated separately with microwave exposures at 0, 15, 30, 45, 60, and 300 seconds with five replications for each exposure. Then the treated and untreated samples were placed with steam-pasteurized soil in 4-inch pots.

To determine nematode viability, tomato seedlings were transplanted into each pot, harvested after 8 weeks, and the roots washed and checked for root-knot symptoms. The results showed that 15-second exposures substantially reduced nematode populations, and based on gall reaction, all exposures above 15 seconds killed all nematode eggs and larvae.

While they are not yet sure if the eggs and larvae were killed directly by the microwave exposure or by the indirect heating effects of microwave energy on the soil, Dr. O'Bannon and Dr. Good say it probably was due to the heating process.

Both researchers point out that further studies with higher-capacity equipment are needed before the economic and practical feasibility of the method can fully be determined. ■

Enzymes detoxify herbicides

HERBICIDES that are more selective and crops that have greater herbicide resistance are two potential dividends from a newly discovered way that plants detoxify atrazine.

Scientists at the ARS Metabolism and Radiation Research Laboratory, Fargo, N. Dak., developed techniques which detect how atrazine, a widely used herbicide, is detoxified by enzymes in corn, sorghum, sugarcane, johnsongrass, and sudangrass. The new techniques may also be used to determine how other herbicides are detoxified by various crops.

Herbicides may then be tailor-made to zero in on a weed's most vulnerable spot—the lack of appropriate chemical guardians to detoxify herbicides. At the same time, scientists may be able to develop crop strains that carry the protective mechanism.

In susceptible plants, atrazine acts as a chemical monkey wrench in the machinery of the chloroplasts—the part of the cell responsible for manufacturing plant food during photosynthesis. Consequently, these plants die or are injured sufficiently to reduce yields.

Resistant plants are protected by natural chemical compounds in the roots, stems, or leaves that react with atrazine before it reaches the target site—the chloroplasts. Not all plants possess the same protective compounds, and even these may be effective against some herbicides but not others. For example, the Fargo scientists recently found that cotton, carrots, and some other plants contain an enzyme that detoxifies certain phenylurea herbicides (AGR. RES. Mar. 1970, p. 7).

More recent tests at Fargo show that corn, sorghum, and sugarcane detoxify atrazine by an enzymatic system in leaf tissue that acts more effectively and rapidly than previously known methods of detoxification. The tests were conducted by ARS plant physiologists Richard H. Shimabukuro and Harley R. Swanson and chemists D. Stuart Frear, Gerald L. Lamoureux, and Wendy C. Walsh.

Their discovery was made indirectly. The scientists found byproducts from atrazine's breakdown that did not correspond to compounds which would be produced by known methods of detoxification.

Two of the breakdown products, identified by Dr. Lamoureux, were typical of compounds resulting from reactions between atrazine and an enzyme that had formerly been found only in rat and other animal tissues. Sophisticated laboratory procedures led to isolation and purification of the enzyme, glutathione-S-transferase, from leaves of corn, sorghum, sugarcane, johnsongrass, and sudangrass. The enzyme could not be detected in six plants susceptible to atrazine injury: barley, bermudagrass, oats, peas, pigweed, and wheat.

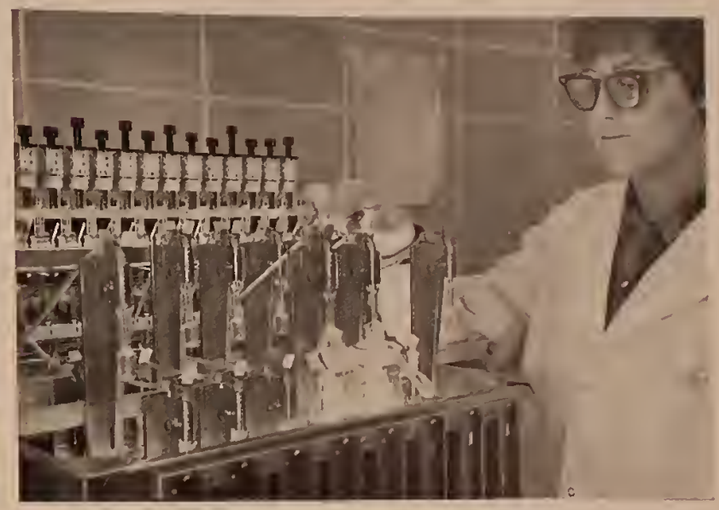
Evidence of enzymatic detoxification of atrazine was obtained in tests of leaf tissue taken from resistant corn. Within 2 hours of exposure, the tissue recovered about 95 percent of the photosynthetic activity exhibited by untreated plants. A susceptible line of corn recovered within 5 hours only about 38 percent of the photosynthesis shown by the untreated plants used as controls.

Previously, scientists attributed detoxification of atrazine to nonenzymatic defense mechanisms, including compounds that not only react with herbicides but are also related to the plants' resistance to European corn borers. The Fargo tests showed that these mechanisms functioned noncompetitively with the new-found enzyme but had a negligible influence, compared to the enzyme's activity in most resistant plants.

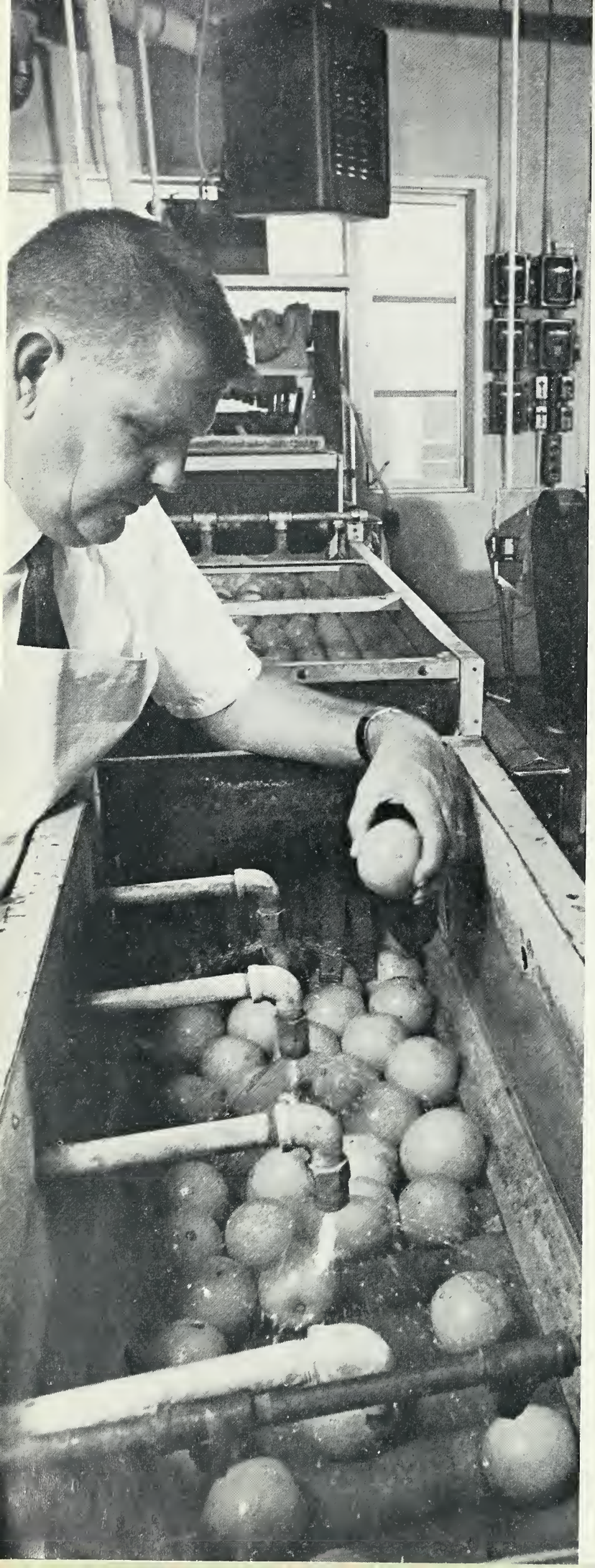
Differences in the amount of glutathione-S-transferase rather than other detoxification reactions in the leaves appear to account for the major differences in the results obtained with resistant and susceptible plants. ■

Mrs. Walsh examines sorghum seedlings growing in what contains a nutrient solution and radioactive atrazine. Water is better than soil for controlling growth factors (BN–35816).

***Left:** Flasks in respirometer (BN–35819). **Below:** Disks cut from corn leaves are placed in respirator to record respiration rates. Rapid recovery of respiration after treatment indicates ability to detoxify atrazine (BN–35814).*



***Top:** Using an ion-exchange chromotography system, Dr. Lamoureux isolates breakdown products from extracts of atrazine-treated plant tissue (BN–35821). **Bottom:** The breakdown products are identified with a mass spectrometer (BN–35817).*



Dr. Smoot examines applications of wax and TBZ to fresh oranges (570A325–11).

TBZ Curbs Citrus Decay

NEW FUNGICIDES tested under laboratory and simulated market conditions protected citrus fruit against post-harvest decay better than most widely used commercial treatments.

The fungicides have no allergenic, toxic, or other adverse effects on the aging, appearance, or taste of the fruit. Effective against green mold and two kinds of stem-end rot prevalent in humid areas, the fungicides were lab-tested on three varieties of oranges which were held after treatment for 3 weeks at 70° F. In that period, decay occurred among only about 5 percent of the oranges treated with thiabendazole (TBZ) at a concentration of 0.1 percent in water. TBZ is registered by USDA for use on citrus.

"Previously, SOPP (sodium orthophenylphenate) had been the best citrus fungicide of some 3,000 experimental compounds tested over the past 25 years," said plant pathologist John J. Smoot, stationed at the ARS Horticultural Field Station, Orlando, Fla. "About 12 percent decay resulted among fruit treated with SOPP, the standard commercial treatment, in our comparison tests."

Decay occurred in more than 20 percent of the untreated Hamlin and Pineapple oranges, and 15 percent of the Valencia oranges. "These decay figures are abnormally low," Dr. Smoot added, "reflecting a season of low incidence of natural decay. In a more normal year, or a bad year, the protection provided by TBZ and other treatments would be more striking."

TBZ treatments were also evaluated on citrus subjected to 3- to 5-day commercial shipments from Florida to Philadelphia and New York, and 2-week holding periods at 70° F., simulating supermarket storage and display conditions. Results were comparable to those obtained in the laboratory.

The TBZ treatments are economical, costing about 1 to 1½ cents per 90-pound box of fruit. In Florida alone, more than 30 million boxes of citrus annually require treatment to prevent mold before sale to fresh produce markets. Fruit for canning or freezing is not treated.

Three other fungicides also gave good results but are not approved for commercial use. A brief hot water dip also killed the fungi, but was less effective than the other treatments.

The Florida Agricultural Experiment Station and the Florida Department of Citrus cooperated in the ARS tests. ■

ARS technician Ken Baldwin adjusts linkage while Maj. Claude T. Adams, Air Force entomologist, waits to start testing (570A326–9).

When Time Counts . . .

ENCEPHALITIS and other mosquito-borne diseases that frequently threaten in the wake of hurricanes, floods, and other catastrophes could be combatted more quickly by planes equipped with an experimental spraying rig designed for fast installation in airplanes.

Entomologists B. Michael Glancey and Clifford S. Lofgren, and technician H. Randy Ford, stationed at Gainesville, Fla., designed an experimental spray apparatus that can be mounted in C–47 planes or other aircraft in only 2 hours. It can be removed even more quickly if the plane is needed for other purposes. In contrast, conversion of C–47 planes for conventional spraying takes several weeks at a cost of about $10,000. The ARS ultra-low-volume sprayer costs about $350.

The experimental unit consists of an ultra-low-volume spray tank from which insecticide is pumped by a battery-powered motor and gear pump. The plane's electrical system could also operate the motor.

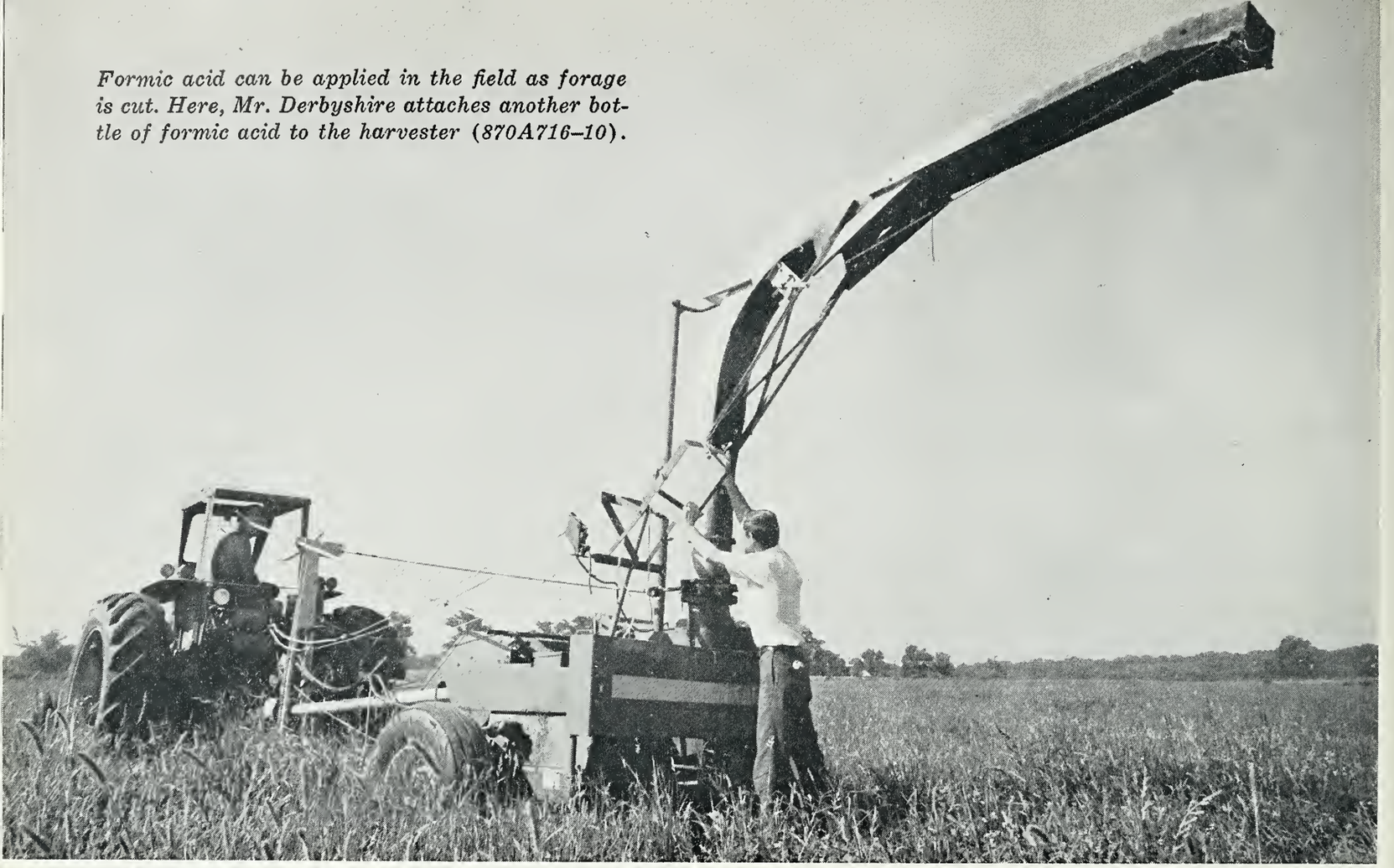
Unlike conventional airplane spray rigs, which have booms mounted on the wings, the ARS unit pumps insecticide to a short boom attached to a standpipe projecting through an inspection hole under the fuselage. Air movement along the fuselage, plus the speed of the plane and the size of the spray nozzles, produces a mist fine enough for an ultra-low-volume application of only 3 fluid ounces of undiluted insecticide per acre. The mist covers a swath about 500 to 1,000 feet wide when the plane flies crosswind, permitting treatment of 150 to 300 acres per minute by planes flying at 150 miles per hour.

Ultra-low-volume applications could help minimize environmental pollution by conventional insecticidal oil sprays that utilize considerable quantities of fuel oil as a carrier for insecticide.

Although only a fraction as much spray was applied in ultra-low-volume tests with the experimental sprayer, results equalled those obtainable by conventional airplane sprayers. About 97 percent of the yellow fever mosquitoes and black salt marsh mosquitoes were killed by malathion sprayed from the experimental ARS unit. The insects were held in cages 2½ feet above the ground in the test areas near Fort Myers and Gainesville, Fla.

Other promising tests have been made in Thailand in cooperation with the World Health Organization to prevent epidemics of dengue and hemorrhagic fever, which are transmitted by mosquitoes. Additional tests have been made in the Panama Canal Zone against other species of mosquitoes. Further tests are planned in Korea and Taiwan by the World Health Organization.

The Lee County, Fla., Mosquito Control District, U.S. Navy and U.S. Air Force cooperated in several phases of the ARS tests. ■



Formic acid can be applied in the field as forage is cut. Here, Mr. Derbyshire attaches another bottle of formic acid to the harvester (870A716–10).

Treating unwilted silage for more milk

MILK PRODUCTION can increase when dairy cattle are fed unwilted silage treated with formic acid.

In a recent test at Beltsville, Md., cows consumed more treated unwilted silage than either treated or untreated wilted silage. As consumption of silage went up, so did milk production.

ARS nutritionist Joseph C. Derbyshire and Chester H. Gordon say that the higher consumption of digestible energy of the treated unwilted silage probably accounted for the higher milk production. In an earlier test, when the silage was of very high quality, the formic acid-treated silage did not increase milk output.

Use of formic acid overcomes several problems encountered when unwilted silage is stored, including large nutrient losses, reduced feed quality and palatability, and foul odors.

Previous studies showed formic acid treated silage to be a big boon to dairy heifers (AGR. RES., Dec., 1966, p. 7). More efficient gains were made when feeding this silage to heifers without concentrates. Improved efficiency was not noted with dairy cows that were fed concentrates along with the silage. Concentrates tend to mask the influence of silage on milk production; however, the greater efficiency of some rations for body gain than for milk production is not uncommon.

Two disadvantages of silage treated with formic acid may be the cost and method of application. Mr. Derbyshire used 10 pounds of formic acid per ton of silage, or about $2 worth. However, the British appear to get satisfactory results with half this amount of acid. Further tests on levels of application may reduce the amount needed. Mr. Derbyshire believes the cost could be brought down even more if the demand were great enough.

Formic acid may be applied in either of two ways: (1) A 55-gallon drum of acid can be put near the blower where the acid drips onto the forage as it is blown into the silo, or (2) a 7-gallon plastic bottle may be attached to a forage harvester where formic acid can drip onto the forage as it is chopped in the field. The second method requires refilling the bottle after chopping one or two loads.

In spite of the problems, Mr. Derbyshire believes that the advantages tip the scales in favor of formic acid as a treatment for silage. ■

Monitoring pollution damage

MONITORING STUDIES show that air pollution injury to plants is a problem in rural areas far from the urban sources of pollution.

Preliminary investigations by plant physiologist Walter W. Heck and plant pathologist Allen S. Heagle, both of ARS, suggest that all U.S. areas east of the Mississippi River may have sufficient photochemical pollution to injure sensitive plants at certain times in their development.

Photochemical oxidants are formed by the action of sunlight on nitric oxide, nitrogen dioxide, and certain sensitive hydrocarbons released by combustion of fossil fuels.

The scientists monitored oxidant damage at locations 5 to 75 miles from the center of Cincinnati, Ohio, between early June and early September of 3 years. Laboratory-grown Bel–W3 tobacco plants were distributed systematically as indicator plants.

Damage was noted almost every day, but the amount of injury varied from site to site in any given week. Total seasonal injury was fairly uniform at all locations.

Plant injury recorded at sites 50 and 75 miles east of Cincinnati indicates that no area of southwestern Ohio is free of oxidant air pollution although Cincinnati possibly is not the major source of pollution at these sites.

There was no consistent relationship between plant injury at monitoring sites and oxidant levels measured at the laboratory, 5 miles from the center of Cincinnati. Differences in weekly injury at these monitoring sites indicate either local variations in phytotoxic potential or differing meteorological conditions affecting plant sensitivity.

Drs. Heck and Heagle say the monitoring system used in their experiments could provide a community with estimates on frequency of damaging oxidant levels, severity of damage, and regional distribution of phytotoxic potency, provided the test plants are grown under uniform cultural conditions.

An important byproduct of this research was that tobacco, previously used under laboratory conditions, proved to be an excellent monitor plant at field locations. Tobacco produces new leaves continuously during the growing season and leaves of different maturity differ in sensitivity but are uniformly sensitive at a given stage of growth. Thus, new injury is easily separated visually from old injury. The plants can also be grown with a minimum of care under uniform cultural conditions.

The highly susceptible Bel–W3 variety, developed by ARS scientists at Beltsville, Md., is especially useful in monitoring oxidant pollution because it shows characteristic, easily identified, and highly specific symptoms.

In contrast, relying on natural vegetation to monitor plant damage is less efficient. Sensitivity of plants may vary because of differences in cultural and environmental conditions. Also, environmental stress may produce injury similar to that caused by oxidants, and plant species may not be distributed uniformly in the monitoring area.

The National Air Pollution Control Administration of the U.S. Department of Health, Education and Welfare cooperated in the studies. ■

This fully expanded, mature Bel–W3 tobacco leaf shows flecking caused by oxidant air pollution (BN–36641).

Genes for High-protein Wheats

ARS agronomist Virgil A. Johnson examines a high-protein wheat that will be used in crosses (PN–1899).

HIGHER-PROTEIN commercial hard red winter wheats are a step closer to reality.

Twenty-six breeding lines, whose grain averages 2 to 3 percent higher in protein than that of present commercial varieties under Nebraska conditions, have been released to wheat breeders by ARS and the Nebraska Agricultural Experiment Station, Lincoln.

These breeding lines will serve as genetic sources of increased protein in the development of commercial varieties with agronomic and quality characteristics desired by growers, the milling and baking industry, and consumers. Breeding and evaluation of a new variety ordinarily requires 10 to 12 years but sometimes may be accomplished in as little as 6 years.

U.S. hard red winter wheats average about 11 percent protein, although levels vary with the variety and production conditions. Grain 2 to 3 percent higher in protein will be less difficult to mill into acceptable bread-type flour, and the nutritional value of the bread will be enhanced.

Besides higher protein, all 26 experimental lines possess effective field resistance to leaf rust, seven have resistance to soil-borne mosaic, and some show measurable field resistance to stem rust. Three lines have equalled the popular Lancer variety in Nebraska yield trials since 1967.

ARS and the Nebraska station initiated research on genetic improvement of protein content in wheat in 1953. This research has been supported in part by the Nebraska Division of Wheat Development, Utilization and Marketing, and the Agency for International Development, U.S. Department of State.

Early in these studies scientists determined that high protein in wheat is a heritable genetic trait that can be transferred readily from one variety to another.

The research also identified several common wheat varieties that possess high-protein capabilities. Major genes for high protein were found in Atlas 66 soft wheat, developed in North Carolina from the South American variety Frondoso crossed with Redhart x Noll. Atlas 66 is a parent of all 26 breeding lines, which trace to crosses that were made at Lincoln in 1953.

ARS agronomist Virgil A. Johnson, Nebraska chemist Paul J. Mattern, and Nebraska wheat breeder John W. Schmidt found that it is usually possible to increase protein content without unfavorably altering the balance of the essential amino acids that make up the protein. Many high-protein lines derived from Atlas 66 are as high in the amino acids lysine, methionine, and threonine as their low-protein parents.

High yields of present commercial wheats frequently are accompanied by a drop in protein content. Dr. Johnson, Mr. Mattern, and Dr. Schmidt also found that higher protein can be achieved genetically without a reduction in grain yield.

Significantly, the higher grain protein of the experimental lines does not depend upon excessively high levels of soil nitrogen. The scientists say it appears to result from more complete translocation of nitrogen from the plant to its grain rather than from a difference in nitrogen uptake by the roots. ■

AGRISEARCH NOTES

SADH Can Affect Apple Shape

SADH, a chemical growth regulator used on apple trees, can have an adverse carryover effect on the shape of apples the following season.

Tests in Washington on Red Delicious apple trees showed that SADH in concentrations of 1,000 and 2,000 parts per million (ppm) applied late in the season, 125 days after full bloom, flattened the fruit the following season sufficiently to affect its commercial grade. SADH treatment also increased the number of fruit set but decreased size. Max W. Williams, ARS plant physiologist, and Richard D. Bartram of Washington and W. Stewart Carpenter of Michigan, both Cooperative Extension Service area agents, conducted the study.

SADH, which is sprayed on trees to increase the number of blooms, decrease watercore disease, enhance fruit color, and increase fruit firmness, breaks down slowly. Therefore, it must be applied early enough to allow time for the chemical to break down before the resumption of spring growth. If applied too late, it will remain in the trees until the following season's growth begins and will delay bloom and adversely affect both fruit size and shape. Also, because SADH is water soluble, rewetting foliage after its application may cause additional absorption of the chemical.

When SADH was applied to Red Delicious apple trees earlier, 80 to 85 days after full bloom, in a concentration of 1,000 ppm, no carryover effects of commercial importance were observed. However, with repeated use of the growth regulator season after season, Dr. Williams warns that adverse fruit shape may occur. In this event, earlier summer applications at lower concentrations may be necessary.

Two apples at right are from trees sprayed with different concentrations of SADH the previous season at 125 days from full bloom. Left is normal apple (PN–1900).

Tomatoes That Resist Spider Mites

A new method of selecting tomato plants resistant to spider mites has proved so simple that Sherlock Holmes undoubtedly would have exclaimed, "Elementary, my dear Watson!"

A study by ARS horticulturist Allan K. Stoner shows that resistance of tomato plants to red and two-spotted spider mites may be directly related to the concentration of glandular hairs on leaves. Leaves with more hairs render a plant more resistant than those with fewer hairs.

Dr. Stoner used two methods of selecting resistant and susceptible plants. The leaf hairs of some groups of plants were counted under a stereomicroscope. On other groups, hairs were quickly estimated by eye. One method proved just as effective as the other on over 1,500 tomato plants.

Second-generation plants from tomato lines known to possess different levels of resistance to spider mites were selected for the study. After the glandular hair counts or estimates were made, spider mites were released onto the leaves and allowed to lay eggs for 72 hours. Each mite layed an average of 28 percent fewer eggs on those leaves with the highest concentration of glandular hairs.

Dr. Stoner attributes the resistance both to the physical barrier that a higher concentration of hairs presents, and possibly to the toxic effect on the mites of the glandular hair secretions.

Dr. Stoner's study is a part of ARS efforts to select and breed for insect resistance into crops.

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AGRISEARCH NOTES

Virus Controls Cabbage Loopers

Cabbage loopers—among the most difficult vegetable pests to control with conventional measures—died in ARS tests when sprayed or dusted with virus formulations alone and in combination with insecticides or bacterial formulations.

Imported cabbageworms, diamondback moth larvae, and fall armyworms also were killed by nuclear polyhedrosis virus and preparations of *Bacillus thuringiensis*, used singly and in combination. However, the virus-bacteria combination reduced control of the fall armyworm below that obtained with the bacteria alone.

Combining the virus preparation with endosulfan, mevinphos, or naled also increased looper control above that obtained with insecticides alone. The 5-year tests, conducted at Charleston, S.C., were made by ARS entomologist Charlie S. Creighton, assistant Thomas L. McFadden, and mycologist James V. Bell. The South Carolina Agricultural Experiment Station, Charleston, cooperated. Neither the virus formulations alone or in combination with insecticides or bacterial formulations are currently registered with USDA for pest control.

Packing Strawberry Plants

Dormant strawberry plants can be held in good condition for several months when packed without moss in 1.5 mil polyethylene liners with the tops overlapped but not sealed. The ARS storage studies also show that plants should be cooled to a temperature of 30° F. within 3 days of digging. They should then be stored at 30° F. and shipped as close to that temperature as possible.

If transit temperatures do not exceed 60° F., the plants can sustain trips of up to 3 days. They should not be exposed for more than 1 day to transit temperatures of 70° to 75° F., and shipment at higher temperatures is not recommended.

Related studies by ARS horticulturist John T. Worthington and technician Carl Vaught at Beltsville, Md., showed that standard wood-veneer wire-bound crates and fiberboard containers, both with polyethylene liners, were satisfactory for storing strawberry plants, provided the containers are stacked to permit adequate airflow necessary for maintaining a uniform 30° F. temperature.

Spacing Cotton for Higher Yields

Pima S–3 and Pima S–4 cotton growers can save seed and obtain better stands and higher yields with proper in-row plant spacing.

ARS agronomist Evie F. Young, Jr., in cooperative research with the Texas and New Mexico Agricultural Experiment Stations, El Paso and Las Cruces respectively, determined that both varieties performed best when populations were maintained at two and four plants per in-row foot.

In field studies, Dr. Young evaluated cotton response to four plant spacing treatments: one plant per foot of row; two plants per foot; four plants per foot; and unthinned with four to 16 plants per foot.

Results showed that none of the spacings affected plant height. But lodging gradually increased from almost erect plants in the wide spacing to slightly moderate with the closer spacing. The effect on the height at which appreciable fruiting began was significant only with the Pima S–3 at the closer spacing. At one plant per foot Pima S–3 yielded 695 pounds of lint per acre and Pima S–4 produced 651. But at four plants per foot yield of the S–3 variety jumped to 876 pounds per acre and S–4 reached 883.

Spacing had little or no effect on fiber quality, but the period of boll set, as revealed by time of harvest, did influence fiber quality. Late season boll set gave shorter, weaker, and finer fiber. Since close spacing tended to delay fruiting, it indirectly resulted in a greater proportion of lower quality fiber.

U.S. GOVERNMENT PRINTING OFFICE: 1970